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Wood Floors and Radiant Heating

From the Editor . . .

For many years we have had the knowledge and technology to build efficient homes and buildings that would have a small impact on the environment. Unfortunately, too often we take the lazy way out, and don't really consider the impact of what it is we are doing to the global environment.

We focus narrowly on the artificial first cost and not the total cost of our projects over their life. Maybe that more energy efficient option will have a slightly higher capital cost, but when operating costs over the lifetime of the building are considered, it will be substantially cheaper for the owner/occupant of the building. But the long term seldom gets considered. The bigger cost may even be to the community and the environment.

North American development patterns are horrendously damaging to the ecosystem. As an industry, we focus on the impediments to ever-greater sprawl and development in the name of economic development, and only pay lip service to the greater good of the community and the environment. We troop to municipal councils across the country on a regular basis, pleading for this or that project and the marvellous community we are creating, when all we are doing is more of the same, with little real attention to community. It may be unpopular to say it to a builder audience, but we do deserve a lot of the criticism that comes our way.

As an industry, we don't give enough consideration to the social impact of our work. A group of houses does not make a community.

Suburban sprawl may be quick and easy to develop, but this development reinforces the automobile culture. The cost to society of lack of rapid transit options because of too low a density adds to the cost of road and service infrastructure, forces people into automobiles for the slightest chores (and in the process contributes to a disintegration of civil society).

We spend vast sums of money to visit other parts of the world, marvel at how liveable they are, but don't seem to learn anything. The footprint of some of the most exciting and liveable cities we visit is not much bigger than the no-man's land we devote to freeway interchanges in large cities!

There are many negatives, and yes, some positives to suburban type of development. But we don't discuss too many of these, and seem unable to face the issues. Yet these are issues we simply have to deal with, and sooner rather than later. As a society, and as an industry, we simply must become lighter on the earth, and be more mindful of the very limited resources we have on this planet. A more harmonious lifestyle doesn't mean giving up a comfortable lifestyle but it will mean making some changes. This will not automatically threaten our livelihood, but will require changes to what we do and how we do it.

It will mean a much more significant use of what is today considered as "unconventional" energy sources such as wind and solar energy, and heat recovery systems, and more efficient use of material resources. If we don't take meaningful action soon, rather than just paying lip service to the issues, draconian steps will be forced on us - whether through carbon taxes, energy rationing, or strict regulations.

Today's media attention is focused narrowly on military and security maters. Other issues don't get much attention, and it is unpopular to question the status quo. However, I maintain that the really significant issue affecting us is not some rogue character hiding in a cave somewhere, but our own actions and the impact they are having on the planet.

We have the ability to reduce our impact on climate change, and all the consequences that go along with that, but we seem unable to take action. It may be late, but we'd better start today if we want to leave a decent world for our children. We've started a new year and a new century. The only resolution that matters is how can we take immediate action to reduce our impact on the earth, and take steps to reverse the damage we've already done.

Richard Kadulski,
Editor

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Wood Floors and Radiant Heating

Wood flooring over a radiant-heated floor isn't much different from a regular wood floor provided it is done correctly.

Wood is once again becoming the flooring of choice for homeowners. Questions are often asked about wood flooring's suitability with radiant heating. Many builders are reluctant to install hardwood floors over radiant heated floors because of problems in the past.

More than 40 years ago when radiant heat was first introduced in North America, floors were heated excessively to compensate for poor levels of building insulation. The high temperatures exaggerated the expansion and contraction in hardwood flooring, causing irreparable damage. Today's well-insulated houses have a much smaller heat load and radiant systems operate at cooler temperatures.

Installing wood flooring over a radiant-heated floor isn't much different from laying a regular wood floor. It is most important that the sub-floor or slab is dry and the installation is done correctly.

All woods absorb moisture when the air is humid and lose it when the air is dry. Changing the moisture content makes a significant difference to the dimensions of hardwood floor products. You can manage expansion and contraction by understanding how hardwoods behave and by following a few simple guidelines for site preparation, handling and installation.

The radiant heat system designer should know the dimensions and species of the wood as well as the building envelope and window specifications so that he or she can do an accurate heating system design. Ideally, the mechanical system should include a humidity control strategy to keep the relative humidity at an even level. This will keep the equilibrium moisture content on the floor stable.

Proper materials handling and job site preparation are the keys to working successfully with any hardwood product. Avoid shipping, unloading or storing unprotected hardwood products in the rain or snow.

Maintain Occupancy-Level Conditions

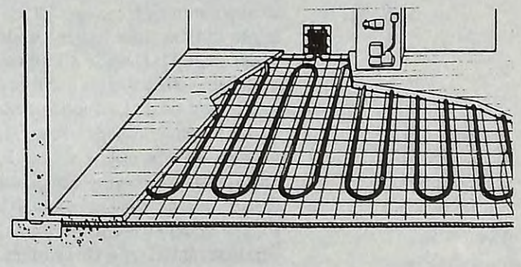
Before the wood flooring is delivered, the house should be at occupancy-level temperature and humidity conditions for at least five days. Excess moisture anywhere in the house should be dried. Drywall should be allowed to dry for at least two days, and plaster for a week or more, depending on weather conditions.

When it's delivered, the flooring should be separated into small lots and stored in the rooms where it will be installed. Most wood is shipped and stored at a moisture content of 6 to 9 percent, which matches average levels in North American homes. However, a wood moisture reading must be done to check the flooring's moisture content at the job site, as it can pick up moisture from the ambient surroundings. It will take at least a week for the wood to reach a balance with the surroundings.

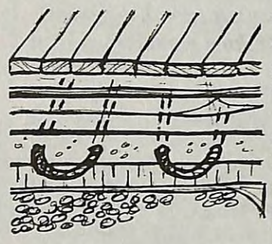
If the wood is too wet, it should be allowed to dry while maintaining adequate ventilation in the room. However, it should not be allowed to dry too much or it will cause installation problems. If the wood is too dry when removed from its packaging, allow it to absorb moisture. Once the wood reaches the desired moisture content, the flooring can be installed.

With the appropriate sub-floor, wood flooring can be installed successfully on either on-grade or above-grade slabs. Never install the flooring over green concrete or wet plywood.

A concrete slab should be well aged before installing a hardwood floor. The slab must be flat and level with a trowel finish, free of grease, oil, stains and dust. New concrete has a lot of moisture, so test for dryness before beginning the sub-floor. If installing wood flooring over concrete or gypsum cement, the floor heating system should be turned on to remove any residual moisture from the slab.



It is also important that the slab have an effective moisture barrier (6 mil poly or better) under



the slab and the slab be on a capillary break (e.g., crushed rock). This will reduce the possibility of ground moisture from being wicked into the house through the concrete and into the wood floor.

A concrete slab-on-grade must be insulated under the slab especially when the floor is being heated. A minimum of R-12 rigid insulation should be used. In regions with a high water table, even higher insulation levels should be considered.

Once the sub-floor, tubing and climate controls have been installed, the heating system should be run for at least 72 hours. Five to six days is better to balance the home's moisture content. For a concrete slab, an even longer period is better.

A simple way to check for the presence of excessive moisture in a concrete slab is to lay a flat rubber mat or tape a 24-inch square of clear polyethylene sheet to the slab with moisture-resistant tape. Look under the mat or poly after 24 hours. If the covered area is wet or condensation collects under the mat, there's too much moisture evaporation from the slab. If there is no condensation, the slab is dry enough for the installation.

Repeat the test in several areas in each room. If the tests indicate excess moisture, wait for the slab to dry, then test again before installing each floor.

Avoid Wide Plank Flooring

Hardwood flooring is available in parquet patterns or pieces that are either less then 3" (strip flooring), or more than 3" wide (plank flooring). All of these will expand and contract with changes in moisture content. Parquet floors are readily used in radiant heat applications. With flooring strips, the wider the board, the greater the potential for gaps between the boards when they experience seasonal moisture changes. It is not recommended to use radiant floor heating under plank flooring wider than 3". Despite all precautions, there is a high probability the user will not be satisfied.

The National Oak Flooring Manufacturers Association recommends two sub-flooring systems: plywood-on-slab and sleeper. Either is satisfactory for strip flooring. For plank flooring wider than 4" use the plywood-on-slab system, or top the sleeper system with an additional nailing surface. The best material for this surface is ⅝" or thicker plywood, or ¾" boards less than 6" wide. Allow ½" spacing between the ¾" boards. Flat, dry 2" x 4" sleepers in random lengths can also serve a nailing base.

Wide plank flooring should be sealed on the back surface before installation but after acclimatization.

Moisture passes primarily through the end grain, so when wood has been cut or mitred, seal the ends with a transparent sealer before installation. If you trim a pre-finished floor, seal the cut edges.

To minimize shrinkage cracks, tongue-and-groove strips are recommended. Profiles with bevelled edges show fewer seasonal cracks.

Plywood-on-slab

The slab has to be covered with a vapour barrier, which can be an asphalt paper or polyethylene, although to reduce indoor air quality problems, asphalt paper should be avoided.

Install the plywood after the vapour barrier is in place. Loosely lay a nailing surface of ¾" thick 4' x 8" exterior grade plywood panels over the entire area, leaving a ¾" space at the wall line and ¼" to ½" between panels. Cut the plywood to fit within ⅛" near door jambs and other areas where finish trim will not be used. Then lay plywood diagonally across the direction of the finished floor to help prevent cracks along panel edges.

Do not use power-actuated fasteners or concrete nails when radiant heat pipes are embedded in the slab. Instead, cut the plywood into 2' by 8' planks and score the backs ⅜" deep on a 12" grid. Lay panels in a staggered pattern with at least 2' long planks along starting and finishing walls.

Allow for Expansion

When laying a solid hardwood floor, leave a ¾" gap at the wall line for expansion. Baseboards will cover the joint.

The heating system should have a set point control that will monitor the floor temperature. The control should either reduce the system water temperature or temporarily cycle the system off to prevent overheating the flooring in case of an equipment malfunction.

An indoor-outdoor control is recommended. This will allow for a more gradual change in the supply water temperature. It will also reduce moisture caused by condensation in a cold slab from being absorbed by the wood – especially during the spring and fall when rapid temperature changes may occur. A more constant supply water temperature at the lowest required temperature maintains the slab at a temperature needed to provide the necessary heat during the heating season.

Standard controls provide a constant water temperature set for the coldest conditions, so at the other times there will be more cycling of the heating system creating more fluctuations in the floor temperature and thus more expansion and contraction. ☼

Information: www.nofma.org/ installation.1.htm

The Performance of Displacement Ventilation Systems

Proper ventilation is a vital element in the healthy operation of a home and in maintaining good indoor air quality.

Conventional ventilation systems, whether fully distributed heat recovery ventilators or an HRV connected to a forced warm air furnace, essentially dilute the fresh air. They assume the air change will be adequately mixed and exchanged. However, just diluting the air does not guarantee adequate air exchange.

How imperfect such a system can be is visually demonstrated by taking two glasses, one filled with black coffee, the other filled with clean water. The glass with coffee represents the polluted air in the house. Pour the clean water into the coffee, while stirring. When all the clean water is mixed with the coffee, it will have replaced the entire volume, i.e., the same as one air change. However, the water will still be murky, showing that just adding and removing water will not provide a total change.

This simple demonstration shows that whole house air change does not solve all problems, and why source control, avoiding bringing pollutants into the house, is also important.

An alternative strategy for ventilation air delivery is known as displacement ventilation. This approach takes advantage of the buoyancy of warm air by introducing cooler fresh air at a low point in the room, and collecting the stale air high up. It recognizes that people generate heat and pollutants, and that warm polluted air will rise. A key principle of displacement ventilation requires a stable temperature gradient between floor and ceiling to drive the air.

Displacement air circulation is designed to provide fresh air directly to people. It has been found to be very effective in commercial environments, especially offices and auditoriums, where fresh air is introduced at the floor or under fixed seating and exhausted at the ceiling.

Displacement ventilation has also been considered for homes. CMHC built a small demonstration house in Ottawa. It had one bedroom, a living room, kitchen, bathroom, and a utility room, but no basement. The house was heated by a radiant floor hydronic heating system and cooled by a small air-conditioning system.

The single-storey prototype was built in two modules by a manufactured housing company and erected at the test site in Ottawa. The house incorporated features of special interest for the environmentally hypersensitive. Hypersensitive persons are a small segment (perhaps 1%) of the population who suffer partial to total infirmity in the presence of airborne contaminants. Some require a home environment that is as free as possible from contaminants. This requires a careful review and evaluation of mechanical systems in addition to careful material selection.

A displacement ventilation system was incorporated into the house and The Institute for Research in Construction monitored the system's performance. The displacement ventilation system consisted of a specially designed air intake and exhaust module mounted on the outside of the utility room, a ventilation unit and ductwork, allowing air to circulate through the house in such a way that cross contamination was minimized. Fresh air was supplied through resisters near the floor level, and exhausted through ceiling outlets in the kitchen, bathroom and closets. The system was balancedso that contaminated air from the living areas could

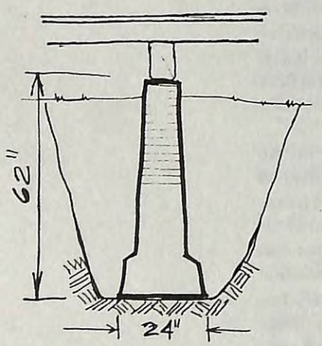
***Study of Displacement Ventilation Systems for Residential Houses with Radiant Floor Heating Systems**, National Research Council of Canada for CMHC*

enter the bedroom because the bedroom was pressurized.

The displacement ventilation system in the demonstration home was found to perform as well as a conventional forced warm-air heating system in distributing the outdoor air to the rooms and in removing indoor contaminants. As with conventional forced warm-air heating systems, the ventilation air was well mixed with the room air.

However, the displacement ventilation system did not produce the typical airflow pattern that characterizes such a system, i.e., the supply air is spread over the floor and then rises when heated by heat sources (e.g., a person) to the ceiling level, carrying contaminants with it. The ventilation system was not able to establish a stable vertical temperature gradient in the room as required for an effective displacement ventilation system. Instead, the displacement ventilation system tested worked like a conventional forced-air heating system in that the ventilation air was well mixed with the room air in the test room. A contributing factor may have been the small areas of each room and the large fluctuation in outdoor and indoor air temperature due to solar gains. ☼

The Footing Tube



The Footing Tube is a new forming product for concrete piers for decks and additions that protects piers them from movement caused by frost and freezing in soils that lift, move and can deteriorate these concrete structures. The form is an easy-to-use, labour-saving device that incorporates the footing and pier into a single pour for added stability and strength. It can be used in frost prone areas with frost lines down to 5 feet below grade.

The lightweight smooth plastic form helps eliminate the negative effects of ground water on concrete by creating an added slip joint. The tapered sides of The Footing Tube give it its resistance to the uplift forces of frost. Because the complete form stays in place, there is no need to strip the form or to wait before backfilling. Compaction of backfill material can even be done before pouring the concrete.

Labelled sizing rings make backfill requirements easier to inspect and also serve as a guide for sizing. The form is manufactured from recycled plastic. The base area is 3.11 square feet including the flanged edge and 2.58 square excluding the flanged edge.

The Footing Tube was developed by Brent Cliff, a Fredericton, New Brunswick builder.

For information:
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Rain Leakage in Wood Frame Walls

Building owners are often faced with difficult decisions when trying to determine the main cause of moisture problems in wood frame buildings. Solving these problems is often complicated by the variety of opinions offered by experts on the source of the moisture. The relative importance of vapour pressure, stack effect and wind-induced pressures as driving forces that move water vapour into wall and ceiling cavities is often at issue. Too often external factors such as rain and wind are overlooked, leading to an incorrect diagnosis, when small changes to building details or maintenance programs might eliminate the cause.

An investigation at a 25-year old house underscores the importance of keeping the principle of house-as-a-system in mind when designing, building, and especially renovating houses.

The house was a 1½-storey single-detached house with a ground floor area of about 750 sq. ft. The owners installed a new oil furnace and upgraded wall and ceiling insulation with cellulose insulation. After the work was done, they noticed higher heating bills, cold walls, and had problems maintaining comfort conditions. Consultants suggested that the heating problem was due to warm moist air exfiltrating into the outside walls, resulting in wet insulation and increased heat loss. The solution suggested was to install exhaust fans to improve the removal of moist interior air and thus control indoor humidity levels.

Detailed investigations, however, suggested other problems. Stains in the attic suggested wetting and drying had taken place - although in August the wood moisture content in the rafters averaged 9%. Five unsealed, uninsulated access hatches to kneewall spaces offered plenty of opportunity for air leakage.

A damp subfloor adjacent to a window on the main floor, and the presence of efflorescence on the inside of the concrete foundation wall suggested moisture transfer from outside to inside had taken place.

Exterior wall shingles had not been repaired properly where they had been broken when the walls had been punched open to access the wall cavity for blowing-in the cellulose insulation. Removal of the wall shingles adjacent to a bedroom window revealed water-soaked sheathing paper behind and below the nail holes and vertical joints in the siding. The sill and window frame had 25-30% moisture content. The sheathing paper had not been replaced when the insulation was blown-in.

An examination of the heating system showed that it was not working correctly, and was the source of the heating system problems. A new fan control was installed, the furnace cleaned, and the return air system cleared of obstructions.

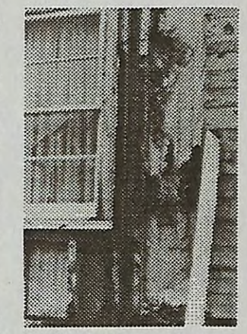
Based on the more careful analysis of potential problems, rain leakage was identified as the source of wall moisture. When the wall was stripped for re-siding, rot was found to be confined to the studs, jacks and sill plate immediately beside and below the window. Shingles removed in areas away from windows where they had not been taken off during re-insulation showed dry sheathing paper and sound dry wood.

To reduce the flow of warm moist air into the walls and attic, the plaster below the windows was repaired and the attic and kneewall hatches were weatherstripped. The following winter the attic remained dry.

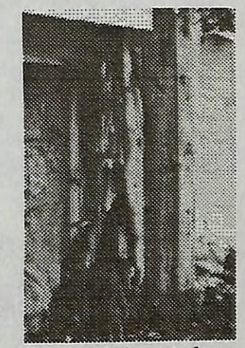
Contrary to expectations, heating oil use increased about 20% after the installation of vinyl siding over the insulated sheathing and the furnace repairs. Higher inside air temperatures and increased hot water consumption could account for this increase.

This investigation showed the importance of proper construction details at joints and changes in materials to the successful performance of buildings. Details that do not encourage the drainage of water, that allow water to run back toward the building face, or that provide a concentration of water at the end grain of wood members are likely to promote rain penetration and moisture accumulation if not carefully maintained. As we use more low maintenance building envelopes, designs and materials, building owners appear to be doing less regular maintenance which could prevent problems.

When doing building renovations and upgrades, contractors should make their crews more aware of the damage that can be done to a building enclosure system, and be certain to provide adequate supervision to ensure that best practice detailing is maintained. ☼



Rot adjacent to window



Damage below window

Rain Leakage in Wood Frame Walls: Two Case Histories, *Building Research Note 210, April 1984*

D. L. Scott
Division of Building Research
National Research Council of Canada

The Impact of Added Insulation on Air Leakage

The use of greater amounts of insulation is promoted to reduce energy consumption. It is easy to calculate the impact on energy consumption when thermal insulation is added to the envelope. However, other effects also have to be considered when adding insulation, such as air leakage through the exterior wall assembly, and the potential for water condensation.

When insulation is added to an exterior wall assembly, it changes the temperature gradient in the wall. As a result, the risk of moisture condensation may increase, especially if warm, moist indoor air can flow through the wall.

Moisture can accumulate in hygroscopic materials (i.e., materials that absorb moisture, such as wood and fibreboard sheathing) and the insulation itself, leading to decay, mould growth and reducing the insulation's thermal performance. Current design practices do not fully consider this when dealing with insulation upgrades. Nor does the computer software used today consider the combined moisture and air leakage through the building envelope. Thermal performance cannot be looked at independently from air and moisture transfer.

The Building Code contains airtightness criteria for materials, and requires airtight construction, but does not spell out how tight the whole assembly must be.

The total air leakage rate is measured for R-2000 certification or Energuide for Houses evaluations, but provides little information about the actual air movement path and where potential moisture accumulation areas are. A study at Concordia University for CMHC looked at the impact of different insulation strategies on air leakage and moisture content in walls when exposed to four months of wetting and drying. The study measured full-sized test panels inside an environmental chamber. The effects of rain, wind and sun radiation were not taken into account in this test.

Impact of Added Insulation on Air Leakage Patterns by Dominique Derome, Paul Fazio and Guylaine Desmarais for CHMC Research Division.

Indoor moisture can move through the wall by means of diffusion or exfiltration through many different types of paths. Exfiltration is the main moisture transfer vehicle, especially in cold weather, so is an important cause of moisture related problems. Air moves through paths created by cracks and joints between materials.

For this study, three types of air leakage paths were studied, each simulating extreme conditions that could occur in a wall.

Long air exfiltration path

The air was assumed to flow into the wall through a 2 mm (1/16") horizontal crack at the bottom of the interior finish and out through a 5 mm (less then ¼") horizontal crack at the top of the exterior sheathing, just below the top plate. This is much like a case where the gap between the interior finish and the floor is not air sealed.

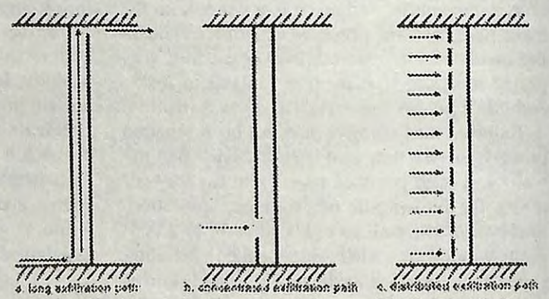
Concentrated air exfiltration path

Air enters the wall through a 20 mm (¾") diameter opening in the interior finish and out through the whole surface of the fibreboard sheathing on the exterior side of the assembly. This is similar to a condition in which air leaves through an electrical outlet but where there is not necessarily a corresponding hole on the cold side of the wall.

Distributed exfiltration path

Air flows uniformly into the wall through 42 holes, 3 mm in diameter drilled in the interior finish and out through the fiberboard sheathing. Such a uniform distribution of openings is arbitrary, as it is not likely to happen in real buildings using standard construction. However, this type of flow was studied because some simulation models only take into account a uniform airflow through an assembly.

The results showed that there is a direct relation between the temperature profiles in a wall and the air leakage path. The moisture distribution pattern also reflects the air leakage path. Moisture tends to accumulate where the indoor air enters the assembly.



Long air exfiltration path | Concentrated air exfiltration path | Distributed exfiltration path

It was also found that moisture levels could rise well above levels capable of sustaining mould growth in localized areas. These can exist in some assemblies even though average moisture content is low.

Two insulation upgrade strategies studied performed quite differently in terms of temperature and moisture accumulation even though they provide the same R-value.

Wall Assemblies Tested

Base-case walls (simulating typical existing conditions without modifications):

2 x 4" wood stud wall insulated with fiberglass batt or blown cellulose insulation, with Tyvek as a wind/weather barrier and asphalt-impregnated fiberboard as the exterior sheathing. Six mil poly as air/vapour barrier, and 19 x 64 mm furring on the interior with ½" drywall.

Interior furring under the drywall is standard construction practice in Quebec. The furring is used to reduce the staining of interior finishes that frequently occurs through thermal bridging at cold wood studs; to protect the air/vapour barrier from being perforated by nails used to hang pictures; and to provide a level backing for the interior finish.

Three test samples insulation upgrades were 38 mm (1½") rigid extruded polystyrene insulation added on the interior side of the wood studs and fiberglass batt insulation. Four other samples insulation upgrades were 38 mm (1½") rigid extruded polystyrene insulation added on the exterior of the assembly directly over the fiberboard sheathing.

Adding rigid foam insulation to either the cold or warm side of existing assemblies increases the thermal performance by 55% for those assemblies with fiberglass batt insulation, and by 66% for those insulated with blown cellulose fibre.

What did the study discover?

Leaky walls tended to behave better when rigid insulation was placed on the warm side.

In walls with holes on the warm side of the assembly, the moisture accumulation was directly opposite the hole on the cold side.

Where insulation was added on the warm side, moisture content generally did not rise above 25%, while it could go up to 70% when insulation was added on the cold side.

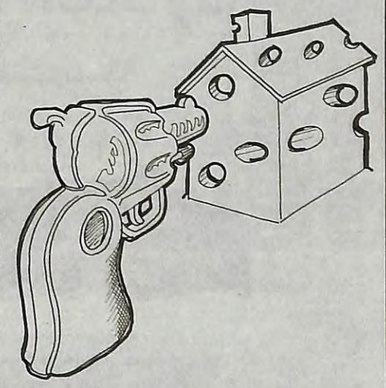
The airtightness of residential buildings is currently evaluated only in a global manner. How airtight a house actually is should be considered before adding insulation. Adding insulation on the warm side of an existing, leaky exterior wall appears to induce less moisture accumulation than adding insulation on its cold side.

Increasing airtightness should be considered before increasing the R-value for existing exterior assemblies. Air leakage should be minimized to avoid moisture problems. ☼

Designing Bulletproof Buildings

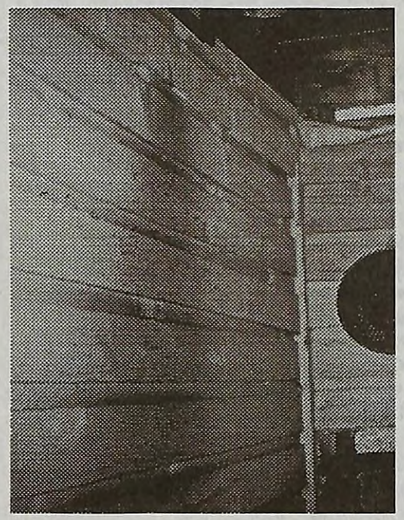
It's a sad commentary on the state of our society that building materials producers of building materials are now promoting their products for their resistance to bullets. This is not an industry from the war-torn Middle East, Balkans or some other conflict zone, or even from the gun-happy USA, but from the Masonry Institute of BC!

It seems that the Canadian Masonry Research Institute and the Royal Canadian Mounted Police did tests on several wall systems with several finishes, including conventional vinyl siding, stucco, and brick veneer. A variety of firearms were used, from a .22 rifle to hand guns, hunting rifles and even a machine gun.



Not surprisingly, the results showed that masonry cladding resists most bullets. As the Masonry Report states: "masonry cladding can provide a measure of safety and security for our homes, schools, and public buildings that is not possible with other wall materials."

What is this world coming to?



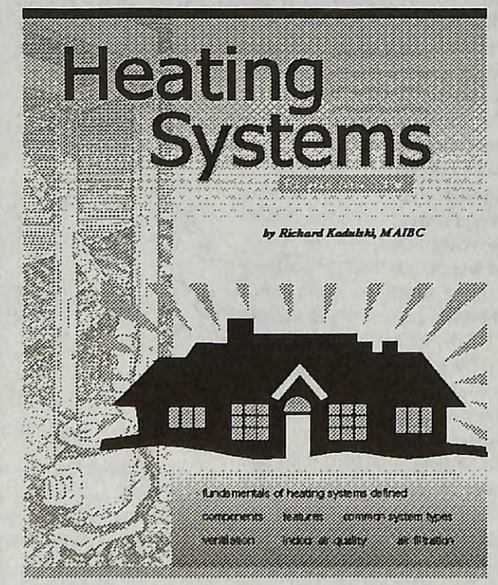
HRVs and Contaminant Removal

Sometimes a picture says it much better than a lot of words. This picture shows an exterior wall under the exhaust grille of the heat recovery ventilator (HRV) in a three-year-old house. The occupants of the house are heavy smokers.

The dark staining is the cigarette smoke tar in the exhaust air stream that has condensed on the siding. While not an endorsement for smoking, it does show that an effective ventilation system does remove pollutants from a house. The interior of the HRV itself will also pick up a lot of contaminants.

This also emphasizes the importance of regular HRV maintenance. Mechanical contractors should consider adding a check of the HRV as one of the things to look at whenever they do any maintenance on a home's mechanical systems.

Builders should consider sending a reminder to homeowners as part of their after-sales service. Such a reminder is not just another task to be done, but should be considered as a marketing exercise - a soft reminder that you still care about your past customers. ☼



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Understanding of *House-as-a-System* is Key to Home Performance

Many of the problems we hear about new R-2000 (or any "energy efficient") homes are not the result of problems inherent with the technology or the construction approach. Rather, the problems are generally the result of a number of issues including improper building and mechanical systems commissioning, construction errors, and a poor understanding on the part of the homeowner of how to operate the home correctly.

The biggest problem builders and consumers have had over the years is in understanding the concept of a house as a system. No matter what technologies and equipment are used, the underlying principle of R-2000 is a systems approach. Problems will occur wherever proper procedures have not been followed.

While builder and installer training is very important, so is homeowner education is. You can't just give a new homeowner the keys and leave it at that. The homeowner does not have to understand in detail all the principles of the various elements in the home - but rather the key points why it is important to operate the house properly. The operations manual should be simple, and should not require a detailed knowledge of building science.

Most people put up with improperly functioning houses because they don't know any better. It's the way it's always been. When we purchase a new car or computer, we expect it to run properly, and if there are problems, a service technician will fix them. We don't seem to have the same attitude when it comes to houses, which in some instances may be more complex. Many of the problems we see in old and new homes are the result of improperly commissioned systems.

One of the biggest problems in new houses is indoor air quality, generally due to inadequate ventilation. Poor indoor air, especially in new houses, is considered by many to be the result of airtight construction which leads to humidity levels that at times are too high or too low, that are stuffy, mouldy, and so on.

What is not well understood is that a ventilation system must be designed to ensure a proper air change in the house and continuity of fresh air. Older houses sometimes had reasonable indoor air quality even though they had no ventilation because they were very drafty. They had several open combustion appliances (such as wood burning fireplaces, naturally vented furnaces and hot water heaters) that generated constant air change through the house.

What must be recognized is that the cost of maintaining older homes at the levels of comfort we expect today is increasing, without any certainty that the desired comfort conditions are achievable. Because of increasing energy costs, many people have been sealing up many of those old houses as best they can, without understanding the need for air change.

Even in newer homes, owners will not run their ventilation system because of a perception that they are wasting money. This shows a lack of education. Let's remember that the volume of air change does not need to be large, but it does have to be continuous because occupancy is continuous. People need fresh air continuously, not periodically when they open windows and doors. A properly designed and commissioned ventilation system, even a simple exhaust-only fan, will not entail an excessive cost penalty, but will significantly improve the quality of indoor air. ☼

R-2000

For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000
r.2000@nrcan.gc.ca
http://ee.nrcan.gc.ca

If It's Not Certified, It's Not R-2000

A house may meet the R-2000 technical standard, but it is not R-2000 unless it has been certified. The certificate is third-party proof of compliance with the R-2000 standard.

Review and certification by a different pair of eyes may not always be popular with builders and trades, but is especially critical in house construction because many trades are involved, and each can affect the work of others. Quality assurance procedures are important to ensure that the design intent and quality standards are met, even if these have not been done during construction.

The technology used in R-2000 homes is applicable beyond R-2000 certified construction. In fact, the intent of the program's sponsors is to encourage wider adoption of energy and environmentally responsible construction practices. However, to gain the full benefit of the technology it must be used correctly. ☼

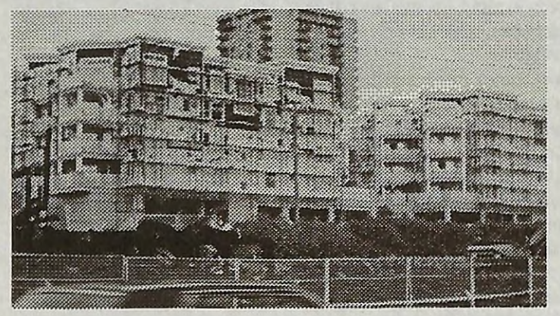
Technical Research Committee News

Canadian Home Builders' Association

Performance of Vinyl Siding

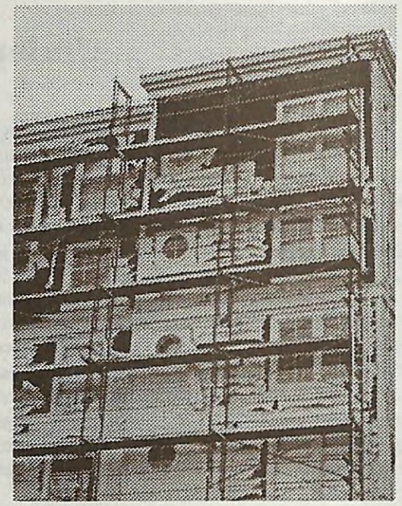
Because it is inexpensive and easy to work with, vinyl siding has become a widely used exterior cladding material. Besides being economical, vinyl is also very effective at shedding water. Experience in Vancouver has shown that, because vinyl must be applied loosely to accommodate thermal expansion, it will act as a rain screen even without strapping to create a deliberate cavity behind the siding.

But vinyl is a plastic and caution is required when using it. We are not going to discuss the concerns that have been raised about the environmental consequences of the use and manufacture of plastics. Rather, we want to add a word of caution about specific problems connected with vinyl products.



Vinyl has a low melting point, so it will soften as it gets warm. This is one reason why vinyl siding must be applied loosely. As vinyl softens, it expands and loses its structural characteristics; it deforms and can be expected to melt when exposed to fire.

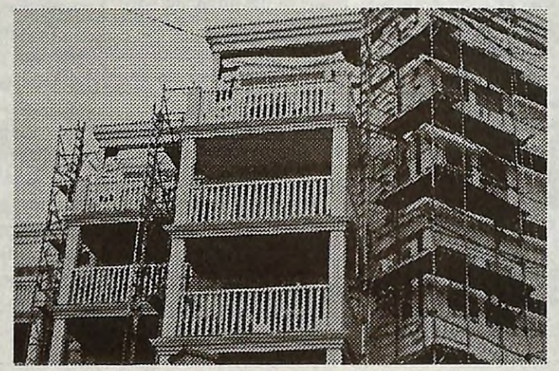
The photos show the vinyl siding on a multi-family project in North Vancouver after a fire burned down an old one storey industrial building on the property across a lane. Because of the sloping terrain, the roof of the building that burned was approximately level with the lowest floor of the multi-family project up the hill. The closest point of the building to the fire was about 100 feet, the furthest more than 400 feet, yet all faces of the project that had a line-of-sight view of the fire suffered serious siding deterioration. Faces that were in the shadow did not experience any fire damage.



This is an example why building codes have requirements for spatial separation between buildings, and why the allowable size of windows, which are considered as unprotected openings, are limited based on the distance to possible sources of fire.

The kind of damage seen here is of course extreme, but vinyl deterioration due to thermal softening has also been noted in areas that experience reflected solar radiation. This may happen where there might be large windows or patio doors and reflecting ponds on the southwest corners of a building. The afternoon sun adds to the heat the elevation receives on a warm sunny day.

Another consideration with vinyl siding is that, like other materials, as it is warmed and softens, it emits vapours. In normal circumstances, under normal conditions the vapours may not have any effect on the home's occupants. However, if the fresh air inlet for the home's ventilation system is on a protected south side vinyl clad elevation that can get very warm, it is possible for some of the volatile emissions from the vinyl to be sucked into the house . For most people, this may not be an issue. But if the occupant is sensitive to chemicals, the vapour factor should be taken into account.



The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
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Tel: (613) 230-3060
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Spillage from Combustion Appliances

Spillage of gases emitted by combustion appliances is always a concern. Older houses were very leaky, so there was little likelihood of a large capacity exhaust fan creating conditions that would spill gases from a fireplace, wood stove or other combustion appliance back into the house. But today's new homes are built much tighter, so dangerous levels of depressurization can easily be reached . (Even older houses, as they are renovated, are tightened up to reduce drafts). That is why the R-2000 program has required the use of pressure resistant combustion appliances such as direct vented and power vented furnaces, boilers and water heaters.

However, there are no performance standards for direct vent or sealed combustion appliances, and there is little information about depressurization limits for appliances. Few manufacturers provide such information, if they acknowledge the issue at all. A study is presently underway in Ontario to determine how various appliances perform. The study is looking at one hundred different spillage resistant appliances, including direct vent, sealed combustion, and spillage resistant fireplaces. Preliminary evidence suggests that not all appliances work as expected, although most of those tested to date can withstand 50 pascals of depressurization.

High Capacity Exhaust Fans and Healthy Home Environment

Large exhaust fans, especially kitchen down draft cook tops and large range hood fans, can compromise the safety of the home environment. Builders who install this type of equipment must ensure that it does not depressurize the house. In most cases this means that an interconnected make-up air supply must be provided.

Unfortunately, any form of interconnect control could affect the safety rating. Builders are caught in the middle. Builders may be held responsible if there is severe backdrafting of combustion appliances, but the appliances' warranties and safety ratings may be affected if the appliances are interconnected to make-up air fans. The solution is for the manufacturers of large capacity exhaust fans to either supply a make-up air kit with their unit, or have a simple connect option for make-up air fans. Attempts have been made to address this issue with appliance manufacturers, most of who are located in the US. Regrettably, so far they have expressed no interest in dealing with the issue.

It would be appropriate for builders to point this out to the vendor and their agent every time such a unit is installed. If enough comments are registered, eventually the manufacturers may get the message that they might be held liable when a problem is encountered. ☼

Consumer Information Bulletin #1

The information contained in this bulletin will be of interest to those who spend money in the marketplace including, but not limited to, unemployed teenagers.

This bulletin, although issued in February 2002, has been in effect since the day someone first discovered that someone else had, or could do, what they wanted.

When considering a purchase, keep in mind that you must select only two of the following:

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Letters to the Editor

Re Humidity Control

I always enjoy **Solplan Review**. In the November 2001 issue, you have an excellent item on indoor relative humidity.

When I returned to Canada in the 1960s after having spent 10 years in the tropics, I found the relative humidity levels in our houses here far too low. I tried a variety of humidifiers, and while they did raise the humidity levels, they also required maintenance and careful operation to avoid the problems listed in the article. For the past 10 years I have stopped using humidifiers. I don't use an electric clothes dryer (a terrible waste of electricity, which should be better used to create employment), but hang the clothes in the basement and the humidity gravitates upstairs.

My main source of humidity in a non-artificially ventilated house is an abundance of plants of all types, which not only provide humidity, but according to many studies also purify the interior air. I believe you have had articles on this in the past, and it certainly is an excellent way to humidify a residence (as well as offices, etc.). It creates a very comfortable and cosy ambiance. During parts of the winter, it can become very cold in Montreal (although not as cold as the Prairies) and this method of humidification is very much appreciated.

It does take time and effort to keep watering the plants, but the overall benefits are rewarding.

T.A.Lawand
Baie D'Urfe, Quebec

Thanks for the comments. You are right to point out that lifestyle can have a big impact on the environment, and may offer a solution in some conditions. Clothes drying and house plants as you describe can be effective means of humidifying a home. However, it is important to remember that the size of the house and its level of occupancy are also factors to be taken into account.

An effective ventilation strategy for the entire house must be part of the consideration in order to minimize the potential of excessive humidity levels. There are too many instances of small homes, often occupied by larger, low-income families, where excessive moisture levels become a health and safety problem. The moisture sources include the high levels of occupancy as well as clothes drying without a dryer (since the family may not be able to afford one) and ineffective or non-existent ventilation. In addition, at some times of the year when humidity levels are in the comfortable 40-60% range, clothes drying inside could contribute to dangerously high humidity levels and lead to other problems.

Whether for new construction or in renovation work, builders may also wish to consider taking a leaf from the Scandinavians' book. See the accompanying article on drying cabinets. Ed.

Re: Issue No. 100 of Solplan Review

You know you are old when you are celebrating a major milestone with a colleague in the industry. I am referring specifically to Richard Kadulski and his whole team at **Solplan Review**, celebrating their 100th issue.

I have been contracting/consulting, etc. for the past 25 years and around 1980 I became very seriously involved with energy efficiency. Throughout my career, many magazines have floated across my desk - some come, some go, some I don't read and some I simply chuck into the garbage. But the only consistent publication I have been reading since it inception 16 years ago, issue after issue, from cover to cover, has been **Solplan Review**. The reason for that is the quality of the articles contained inside.

I truly wish Richard and the team continue on for another 100 issues and that the quality and the content remain as strong as it has been. I have really enjoyed the magazine, and I wish you all the success in the future.

Congratulations, Richard, to you and your team!

Jack Parsons
Flatrock, NF

Re: Issue No. 100 of Solplan Review

On behalf of the Canadian Home Builders' Association, I would like to congratulate you on the recent 100th edition of **Solplan Review**. Over the years, **Solplan Review** has become a 'must read' for all those who want to keep abreast of the latest in housing technology.

As testament to the value of this publication, CHBA has a longstanding arrangement to provide all of its new home builder, and renovator members with a subscription as a benefit of membership. A meeting of CHBA's Technical Research Committee seldom occurs without reference to this important magazine.

Best wishes for the future.

Dick Miller, President
Canadian Home Builders' Association

You Asked Us:
About Drying Closets

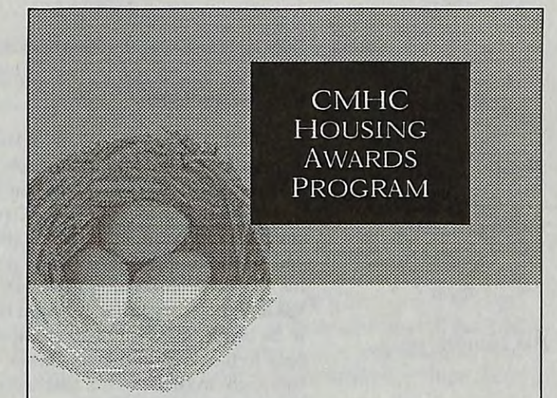
When I was in Finland, I saw a house with a drying closet, i.e., a place to hang wet clothes from the washing machine and let them air dry. I think it must have had special ventilation because it didn't take too long to dry clothes, even heavy ones. The house owners had a washer and a dryer but had never bothered using the dryer because the drying room was so efficient. Do you have any information on these drying rooms or closets?

Drying closets are common in Scandinavia. The drying rate will depend on the moisture content of the clothes, the air flow, and the temperature and humidity of the air. Drying closets could be connected to a central ventilation system for the house, or kept separate with their own stand-alone fan. Simply put, they are closets where wet clothes are hung, and a fan is used to move air past the clothes. The exhaust fan could be part of the home's exhaust ventilation system.

Drying closets are more energy efficient and easier on clothes, which don't get the rough tumbling of a dryer. Drying closets have not been built often here in Canada, although there is no reason why they cannot be. Construction would require careful detailing so as not to create moisture problems in the drying closet and adjoining areas.

If a drying closet is to be used, you should also have a horizontal axis washing machine - which is more effective at removing moisture from clothes - some fabrics come out almost dry after the fast spin cycles. The standard North American top loading tub type washer leaves clothes very wet when removed, so drying times would be much larger.

However, overall moisture in the house has to be managed carefully. As Tom Lawand points out in a letter to the editor in this issue, during the coldest and driest times of the year, you might not even need to use an exhaust fan, as the humidity from the drying clothes could contribute welcome humidification for the home. But you don't want to add too much moisture and create conditions that will make it worse. In the winter, the environment is drier, so drying would also take place much faster and can contribute welcome humidity. In the fall and spring, humidity levels can be quite high, so you do need to control indoor humidity levels. ☼



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Energy Answers

Rob Dumont

How do compact fluorescent lamps work, and how do they differ from standard incandescent lamps?

Standard light bulbs – incandescent bulbs – operate on a very simple principle: An electric current passes through a tungsten filament, the tungsten heats up to about 3000 °C (very hot – the surface temperature of the sun is about 5700 °C) and glows, emitting photons of light. To prevent the tungsten from burning up prematurely, an inert gas mixture of argon and nitrogen is often placed in the lamps. This form of incandescent lamp dates back to the time of Thomas Edison and Thomas Swan, co-inventors of the first successful carbon filament lamps in 1878. The principle is simple, but the efficiency of the lamp is poor. Only about 5% of the electrical energy passing through the light bulb is converted into useful photons of light. The rest is heat.

An efficiency of 5% seems very poor, but candles are much worse. Typical candles are about 100 times less efficient at converting energy to light.

Edison once boasted that he would make electric lights so cheap that "only the rich could afford candles." Edison was mostly right. Compared to candles and incandescent lamps, compact fluorescent lamps are much more efficient, but also more complicated. In a fluorescent lamp, a small filament at the end of the lamp is first energized, and the filament emits a small number of photons of light. The photons hit atoms of mercury vapour inside the lamp, the mercury atoms emit electrons, and the electrons strike the phosphors which are placed on the inside of the outer glass shell of the lamp. The phosphors then emit larger quantities of light. The colour of the light output depends on the types of phosphors used. The first fluorescent lamps were only demonstrated to the public in 1939 at the New York World's Fair. Claude Neon, a French inventor, created the fluorescent lamp. Fluorescent lamps convert about 20% of the electrical energy passing through them into useful light; the remainder is heat. That 20% conversion efficiency is not great, but it is about four times better than incandescent lamps, and the reason why most commercial buildings almost exclusively use fluorescent rather than incandescent lamps.

Can compact fluorescent lamps work in very cold temperatures?

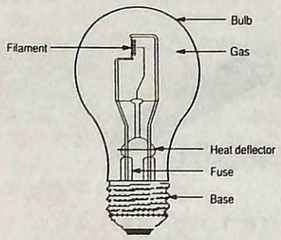
Fluorescent lamps are more sensitive to temperature than incandescent lamps. We recently had a high school student on work experience examine the performance of several compact fluorescent lamps at room temperature and at -30 °C.

The good news is that all of the compact fluorescent lamps will eventually fire at -30 °C. The bad news is that the light output from the cold fluorescent lamps was very poor. On average, the light output of the lamps at -30 °C is only 11% of the output at room temperature. The one exception was a Panasonic Fluorescent Lamp, which had a cold temperature light output of 50% of its output at room temperature. The Panasonic lamp is the one we would recommend for outdoor use in cold climates. A number of the Philips Earthlights will also function in very cold temperatures. The Panasonic and Philips lights use an amalgam of mercury, not pure mercury, in order to better function under cold temperature conditions.

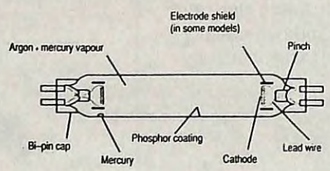
Where can you buy compact fluorescent lamps at a decent price?

I have recently purchased CFLs at Home Depot for $6.98 each plus taxes for either a 15 or 20 watt input lamp. The lamps are almost, but not quite, as short as regular fluorescent lamps. The lamps are rated for 10,000 hours of life, as opposed to 1,000 hours for most incandescent lamps.

Typical Construction of an Incandescent Lamp



Typical Construction of a Fluorescent Lamp



Typical Construction of Incandescent and Fluorescent Lamps
(Diagrams courtesy of Lighting Reference Guide, Canadian Electrical Association)

The environmental effects of the CFLs are impressive. A 20-watt CFL lamp, which can replace a 100-watt incandescent lamp, will save 800 kilowatt-hours over its 10,000-hour life. Here in Saskatchewan, where lignite coal is used for electricity generation at a conversion rate of about 2.4 pounds of lignite per kilowatt-hour of electricity, that single 20-watt compact fluorescent lamp over its life will save about 1,920 pounds of coal! Not bad – one CFL light bulb saves almost a ton of coal, plus 9 other incandescent light bulbs that did not have to be purchased. ☼

Solplan Review Back issues

A limited number of back issues are available, at a special price of $5.50 each (plus 7% GST).
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e-mail: solplan@direct.ca

Did You Know:

Each Gas Pilot Light Can Cost $92.00?

That innocent looking little pilot light that burns all the time in the furnace, water heater, or gas fireplace is a big guzzler of natural gas. The annual consumption depends on the size of the flame, and can vary from 700 to 1,000 BTU/hr, which is 6.5 to 9.2 GJ of gas (or about 61 to 87 therms). Some fireplace pilot lights can consume as much as 2,000 BTU/hr!

The price of natural gas has been fluctuating recently, but at a cost of $10.00 per GJ (the approximate cost of gas in Vancouver recently) this means that each gas furnace and hot water heater can cost the homeowner up to $92.00, fireplaces even more, before they do what they are supposed to do. This may not seem like much, but consider that in most gas fired houses there will be several appliances. Unless all are high efficiency units with electronic ignition (which is seldom the case) they are putting a tax on each home.

The argument that the heat given off by the pilot lights will contribute to space heating is not valid because the heating season is seldom more than five to six months long, even less in a well-insulated building. For the rest of the year the pilot lights actually contribute to overheating of the house.

Electronic or spark ignition technology is refined today, so those old timers' tales about poor reliability no longer apply.

If you are a builder, why are you imposing such a cost on your customer?

If you are a renovator, or simply adding new appliances or replacing existing units, why would you want to pay so much extra?

Health, Safety and Domestic Hot Water

Hot water systems must provide a healthy and safe supply of hot water. A hot water system can be a perfect breeding habitat for Legionella and other bacteria, especially at the bottom of a hot water tank where scale and sediment accumulate. Domestic hot water stored at low temperatures can also allow the growth of bacteria including Legionella. However, water at temperatures above 120°F (50°C) increases the possibility of scalding, so to reduce the risk of accidents the maximum recommended temperature at all domestic taps is 120°F.

Control measures effective in minimizing Legionella will also be effective against many other species of waterborne bacteria that thrive under similar conditions. To avoid the growth of potentially dangerous bacteria, domestic hot water should be stored at a minimum temperature of 140°F (60°C). This also means the tank and piping should be well insulated - better than the minimum insulation on standard tanks.

Hot water piping presents an even more complex problem than tanks because bio-film and scale forms in the valves, fittings and on the pipe walls providing food for bacteria and protecting the bacteria from hot water and chemical disinfectants.

With the need for 140°F storage tank temperatures comes the need for protection from the risks of scalding. The most effective means to help protect your customer is the use of thermostatic mixing devices.

Thermostatic mixing valves are the most commonly recognized scald protection controls. The temperature is controlled by a thermostatic element that adjusts the mix of hot and cold water according to the temperature setting of the valves. These valves allow the storage of very hot water that will kill off bacteria but still deliver safe and proper water temperatures through the whole system. Devices can be built into or fitted onto the outlet of showers, taps or bath spouts to shut off the flow of water if the temperature exceeds 120°F (50°C). ☼

NRC·CNRC

Recent Housing-Related Activities at IRC

By Jim Gallagher, Manager of Publication Services at the NRC's Institute for Research in Construction.

This article reports on some of IRC's recent research and technology activities conducted on behalf of the housing industry.

Guidelines for Basement Envelope Systems

Some of the results of IRC's basement research have been reported in previous issues of Solplan Review. Currently four building practice chapters covering performance requirements, system selection, material and equipment selection, and design details are being developed. These should be available by spring 2002.

Durability of High-Performance Glazing Units

IRC is continuing its research with industry to improve the performance of sealed windows, including studies of different insulating gases for use between the panes. A related study concerns the performance of the sealant that retains the insulating gas. The goal is better sealants that reduce gas leakage, ensuring better window performance. Another important project has been the evaluation of different kinds of non-metal spacer bars that could be alternatives for the usual metal spacers that keep the panes separated.

Material Emissions and Indoor Air Quality

A joint project between NRCan, CMHC and IRC is seeking to assess how materials such as carpets and paint used in a new house can lead to emissions and affect indoor air quality. This will provide, among other things, information to assist in the selection of various materials for use in R-2000 houses. This continuing study was the first research undertaken in the Canadian Centre for Housing Technology.

Fire Resistance and Sound Performance of Wall Assemblies - Phase II

IRC has recently completed Phase II of its comprehensive study of the fire resistance and sound performance of wall assemblies incorporating gypsum board in steel-frame and wood-frame load-bearing walls with shear membranes. Revisions to Table A-9.10.3.1.A in the NBC Part 9, Appendix A, will incorporate these results.

Steel Framing for House Construction

IRC's Canadian Construction Materials Centre, in partnership with the Canadian Sheet Steel Building Institute (CSSBI), has made it easier to build steel-frame housing and small buildings through its technical guide that allows light steel-frame (LSF) floor and wall assemblies to be used in Part 9 buildings without requiring further project-specific engineering. The technical guide addresses performance criteria for heat transfer, air leakage, condensation control and structural performance, including vibration criteria for floor joists.

Proposed Code Changes

In October of 2002, the Canadian Commission on Building and Fire Codes, in cooperation with the provinces and territories, will conduct public consultation on technical changes to both the national codes and provincial codes. A few of the more significant proposed changes are highlighted here.

Ventilation. Because of the troubles builders have had meeting the prescriptive mechanical ventilation requirements in Section 9.32 of the National Building Code, the Standing Committee asked a task group to propose changes. The proposed revisions to Section 9.32 include the following:

- ☞ The outdoor air duct to a forced air heating system must incorporate both an adjustable damper and a mechanical damper. The airflow in the duct must be measured and the damper adjusted to ensure that excess cold air does not flow over the furnace heat exchanger. The mechanical damper must only open when the principal ventilation fan is operating.
- ☞ If spillage-susceptible combustion equipment is present, all exhaust devices other than the principal ventilation fan (e.g., bathroom and kitchen exhaust fans) must be linked to make-up air fans of the same capacity.
- ☞ If no spillage-susceptible combustion equipment is present, an exhaust-only ventilation system can be used. The dwelling must have a forced air heating system or an air handling system linked to the principal ventilation fan to ensure that the outdoor air drawn in through the building envelope is circulated evenly throughout the dwelling.
- ☞ If the mechanical ventilation system can depressurize the dwelling, and it contains combustion equipment or an attached garage, the dwelling must include carbon monoxide detectors in various locations.
- ☞ The alternative of designing the ventilation system to comply with CSA Standard F326 continues to be available.

Carbon Monoxide Detectors. In addition to the CO detector requirement mentioned above, an alternate, more comprehensive CO detector requirement will be part of the public consultation package. The proposed change would require CO detectors in any dwelling that incorporates any type of combustion equipment or an attached garage, regardless of the configuration of the ventilation system. A similar change is proposed to Part 6 of the NBC and thus would apply to all residential buildings, regardless of size.

Lateral Load Resistance of Part 9 Buildings. Lateral load resistance is often overlooked in the design of Part 9 buildings because houses have a lot of inherent lateral load resistance. However, larger houses with non-traditional configurations (e.g., open floor plan, two-storey high rooms) are more common today and this raises concerns. Proposed Part 9 changes would define configurations (combinations of braced walls and openings) where lateral load analysis will be required.

Keeping the Rain Out. A proposal from Nova Scotia (at the urging of the Nova Scotia Home Builders' Association) requested that the National Building Code require a vented air space behind cladding. As a result, proposed requirements have been developed. In some cases a wall will be required to have two planes of defense against moisture ingress. In some situations, the two planes of defense will have to be separated by a capillary break. Normal vinyl or metal siding placed over sheathing paper would satisfy both of these requirements by virtue of the vented spaces behind the siding.

To identify locations where the more stringent requirements would apply, a new climatic indicator – the moisture index – would be added to the table of climatic data in Appendix C. The index will be a single number that takes into account the amount of rainfall and the duration of drying periods, and is based on research conducted as part of IRC's Moisture in Exterior Wall Systems (MEWS) project. Coastal areas tend to have high moisture indices and prairie areas tend to have low moisture indices.

Other Proposed Changes.

- ☞ That basement windows be large enough to be used for emergency egress even if there is no bedroom in the basement.
- ☞ Higher masonry foundation walls for a given thickness when the masonry incorporates reinforcing.☼

For a more complete report on IRC's work on behalf of the housing industry, readers can access the report, "Advancing Canadian Housing Technology," on the IRC web site at:
http://www.nrc.ca/irc/fulltext/nrcc45200/nrcc45200.pdf

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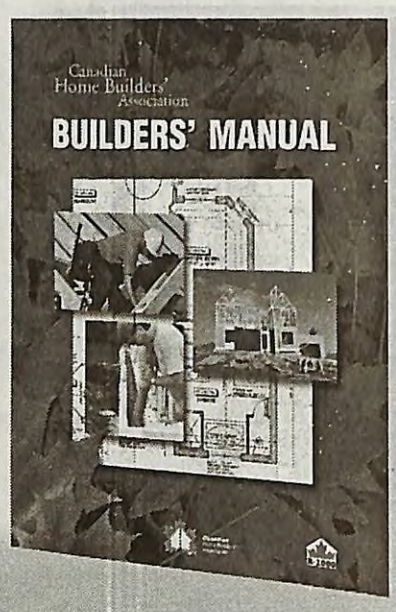

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